DEFENSE LOGISTICS AGENCY

AMERICA'S COMBAT SUPPORT LOGISTICS AGENCY

Powering the Future: DLA's Hydrogen Fuel Cell Pilots

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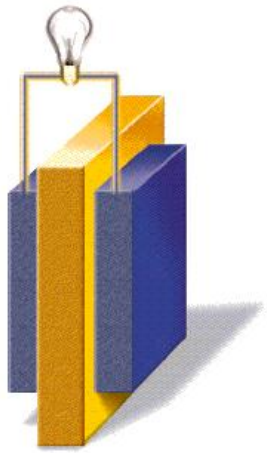
Presentation Overview

- Fuel cell basics
- DLA's H_2 and Fuel Cell Technologies R&D Program
  - Forklift/H_2 infrastructure pilot projects
  - Program expansion to increase H_2 demand and utilization
- User's lessons learned
  - Safety
  - Stakeholder buy-in
  - Program development and execution
- Industry's lessons learned
  - Permitting
  - Contracting agreements
  - Codes and Standards

Hydrogen Fuel Cell Basics

<u>Energy production:</u>

- Break H_2 bonds to generate electricity
- Byproducts: water & heat



<u>Potential Applications:</u>

- Electric drive motors
  - Automobiles
  - Material Handling Equipment (MHE)
  - Trains
- Man portable power
- Stationary backup power
- Large power systems

Hydrogen and Fuel Cell Benefits

- Operational benefits over batteries
  - Rapid refueling
  - No battery management (changing, charging, disposing, Hazmat)
  - Constant power
  - Fuel cell forklifts offer most value in three shift operations
- Environmental sustainability:
  - Fuel cells are highly efficient:
    - Capture regenerative breaking
    - Hybrid systems using ultra capacitors or small batteries
    - Capture load lowering energy
  - No fuel cell 'tailpipe' emissions
  - Potential for "green" hydrogen production pathway – zero GHG emissions

DLA's Hydrogen and Fuel Cell Program MHE Pilots: Goals

- Be an ***early adopter*** and ***principal demonstrator***
- Foster competition in the marketplace and provide a market demand
- Support improved Technology and Manufacturing Readiness Levels (TRLs and MRLs)
  - Exercise the supply chain
  - Test under real world conditions
  - Provide feedback to manufacturers
  - Position fuel cell technology for consumer markets
- Highlight the business case for fuel cells
- Further cost reductions through both R&D and volume

Improve fuel cell readiness by funding R&D efforts in areas that are near commercialization

DLA's Hydrogen and Fuel Cell Program

4 Fuel cell forklift demonstration projects

Approach:

- Pilot multiple H_2 generation, dispensing and fuel cell technologies to power MHE in warehouse operations
- Analyze operational data to establish an operational business case compared to incumbent technologies

Collaborators:

3 Leading fuel cell mfg, 2 leading hydrogen mfg, DLA/DOE/NSWC Crane/NREL with multiple prime contractors

Funding (Congressional):

FY07: $12.7M FY08: $13.9M FY09: $8M FY10: $6M

Locations:

DDSP: 40 forklifts, delivered (cryogenic) H_2, indoor dispensing
DDWG: 20 forklifts, onsite natural gas reformation for H_2, mobile refueling
JBLM: 19 forklifts, 1 bus, wastewater digester gas H_2
DDJC: 20 forklifts, electrolysis for H_2, Power Purchase Agreement (Solar)

Duration: 2 years each

Business case analysis based on performance and cost data collect by NREL

Moving Forward

Extended Range Utility Vehicle

- Beginning Phase II: construct and implement 2 Phase I designs
  - Funding: $3.5M amongst several awardees
  - Delivery expected Fall 2010

Spiral Development at DDSP & DDWG

- Expand the technical requirements and/or capacity of ongoing DLA demonstration projects
- Stock selectors and “Yard Tractor” source selection in Dec 2010

Ford ICE Bus

- Utilize H_2 capacity and expand interagency partnerships





DLA H_2 R&D – Users' Lessons Learned

Business Case Analysis

Analyzing the business case for fuel cell MHE at 4 sites:

- Teaming with NREL on data collection and analysis
- 99 fuel cell forklifts, 1 bus
- Will take 2-3 years to compile (protecting proprietary info)
- To support transition planning (R&D to operational)

Comparing:

- H_2 fuel cell *vs.* battery-electric and propane powered MHE
- Delivered liquid H_2 *vs.* H_2 produced on site *vs.* H_2 via solar-electrolysis
- Full fleet vs. partial fleet replacement

Cost categories included in analysis

- Hydrogen production/delivery
- Hydrogen infrastructure O&M
- Fuel cell O&M
- Refueling time
- Floor space (indoor & outdoor)
- Power to operate infrastructure

Lessons Learned: Project Development

- Work closely with host activities to:
  - Identify realistic goals and define program deliverables
  - Generate MOA with participants to establish and document responsibilities
- Track and implement improvements made along the way in future development
- Plan with the end in mind (consider transition from R&D early; consider the business case)

Lessons Learned: Develop Buy-In

Socialize early – instill confidence!

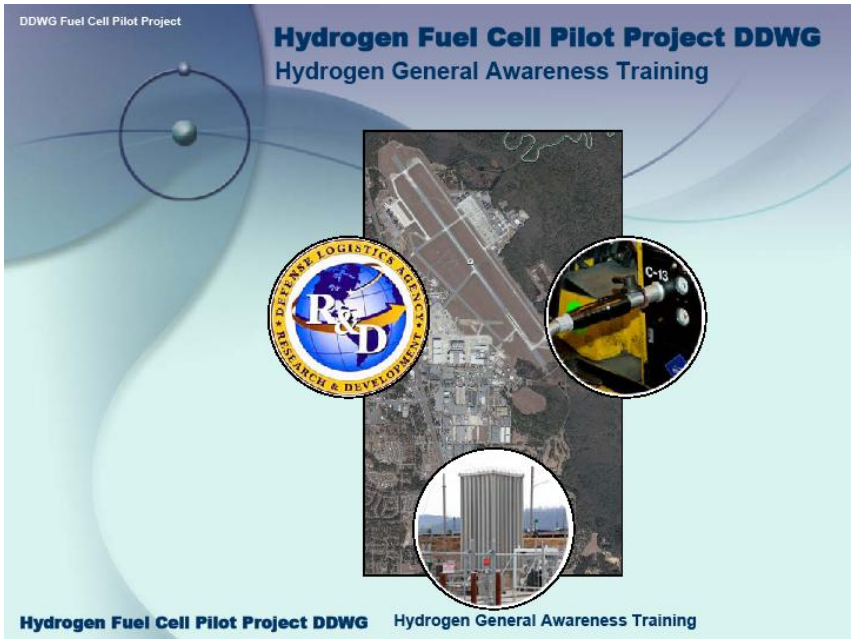
- Hold early and regular informational meetings
  - Command, Users, Union, PAO, Physical Security, ***Fire Department***
- Hand out brochures
  - Highlight benefits but recognize safety concerns
- Focus on system safety features
  - Dispel "Hindenburg" misperceptions
- Provide awareness training for all employees
- Heavily promote response procedures

Lessons Learned: Permitting & Site Approval Process

- Early introduction to site safety/environmental team
  - Developing codes/regulations slows approval process for state/Federal/site permitting
  - Uniform Facilities Code: review and analysis by FPE
- Share lessons learned
  - Share permitting process with DoD activities considering hydrogen pilot programs
  - Share permitting process with commercial sector generating codes and standards
  - Harmonize IFC, NFPA and UFC
    - UFC revision in 2009

Lessons Learned: Training

- Content specific to those being trained:
  - General Awareness Training
    - ~2500 trained
  - First responders
  - Refueling personnel
  - Forklift personnel
- Small training group size
  - Size as needed for hands-on interaction
- Complicated with more than one FC type
  - Physical aspects of fuel cells
  - Getting used to refueling
  - Running out of fuel







DLA H_2 R&D – Industry's Lessons Learned

Hydrogen and Fuel Cell Challenges

Challenges to widespread use:

- High cost
  - Fuel cells and hydrogen production
  - Even higher for ‘green’ hydrogen technologies
- Fuel cell durability
- Hydrogen storage
  - Onboard storage capacity for long range capability
- Infrastructure
  - Fueling stations
  - Production
  - Distribution

- Public acceptance
- Switching from production pathways focused on conventional feedstocks

Improved TRLs and MRLs

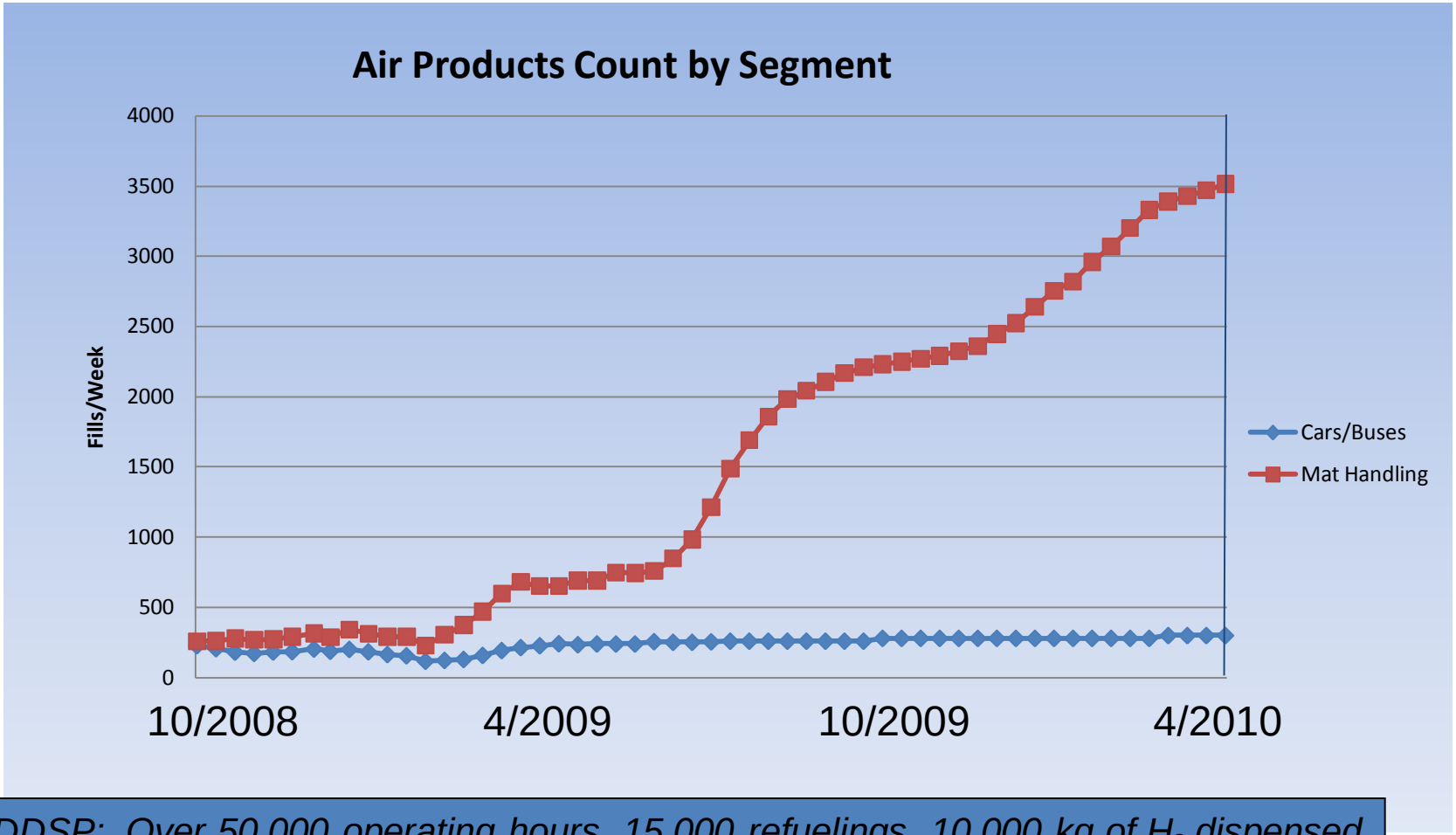
***TRLs* (Technology Readiness Levels)**

- A measure of technological readiness based on a defined set of criteria and standards.
- Used to quantify technology risk.

***MRLs* (Manufacturing Readiness Levels)**

- A measure of manufacturing readiness or producibility based on a defined set of criteria and standards.
- Used to quantify manufacturing risk.

Hydrogen Dispenser Fills



DDSP: Over 50,000 operating hours, 15,000 refuelings, 10,000 kg of H_2 dispensed

Courtesy Air Products and Chemicals, Inc.

Improved TRLs and MRLs

- Improvements realized:
  - High pressure CHC
    - first CHC 7000 at DDSP
    - 16 months operating data
  - Cascading manifolds
    - actuated valves/fittings
  - Dispenser reliability
    - check valves/nozzle
  - Dispensing techniques
    - multiple vehicle logistics
  - Dispenser installation codes
    - NFPA 52 2006 edition
    - changes in 2010 edition

- Anticipated
  - On-site generation
  - Distribution models
  - Below grade storage
  - MHE/Fuel cell interface

Prime Contractor Challenges

- Fuel Supply Options
  - SOG *vs.* SOE
  - On-site generation
- Pricing structure
  - Monthly Service Charge vs. Purchase
- Infrastructure equipment
  - demonstration to operation
  - significant change in usage
- OEMs / pack developers
  - Shifting market
- MHE
  - New market

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